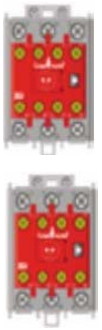
Application Technique

Allen-Bradley

Safety Function: Door Locking and Monitoring

Products: TLS3-GD2 Interlock Switch, GuardLogix Controller, POINT Guard I/O Safety Modules

Safety Rating: CAT. 3, PLd to ISO 13849-1: 2008



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LISTEN. THINK. SOLVE.®

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

General Safety Information

Contact Rockwell Automation to find out more about our safety risk assessment services.

IMPORTANT This application example is for advanced users and assumes that you are trained and experienced in safety system requirements.

ATTENTION: Perform a risk assessment to make sure all task and hazard combinations have been identified and addressed. The risk assessment can require additional circuitry to reduce the risk to a tolerable level. Safety circuits must take into consideration safety distance calculations, which are not part of the scope of this document.

Introduction

This safety function application technique explains how to wire, configure, and program a Compact GuardLogix® controller and POINT Guard I/O™ module to monitor and lock a TLS3-GD2 interlock switch mounted on a door. If the gate is opened or unlocked, or a fault is detected in the monitoring circuit, the GuardLogix controller de-energizes the final control device, in this case, a redundant pair of 100S-C contactors.

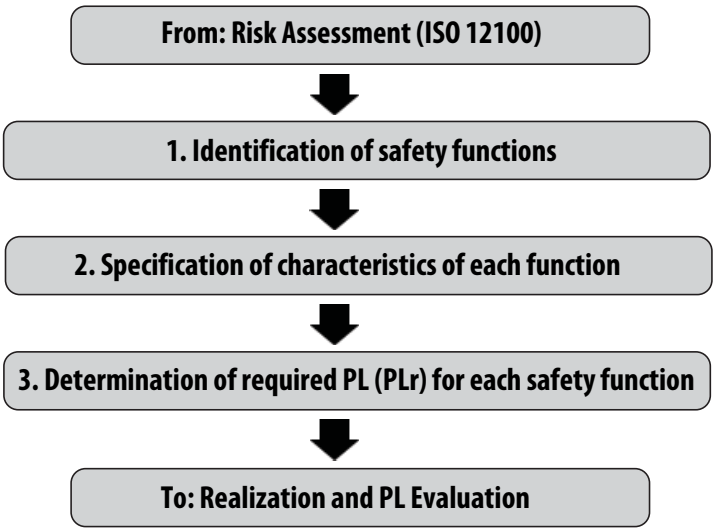
This example uses a Compact GuardLogix controller, but is applicable to any GuardLogix controller. This example uses a TLS3-GD2 interlock switch, but is applicable to power-to-release locking switches with at least two N.C. door contacts and at least one N.C. lock contact.

Power-to-lock switches can use this document with one simple change in the ladder logic. This example assumes that the jumpers in the TLS3-GD2 switch have been removed, and that separate feedback is available for both the lock and the door.

The SISTEMA calculations shown later in this document would have to be re-calculated using the actual products.

Safety Function Realization: Risk Assessment

The required performance level is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. In this application, the performance level required (PLr) by the risk assessment is Category 3, Performance Level d (CAT. 3, PLd), for each safety function. A safety system that achieves CAT. 3, PLd, or higher, can be considered control reliable. Each safety product has its own rating and can be combined to create a safety function that meets or exceeds the PLr.


From: Risk Assessment (ISO 12100)
1. Identification of safety functions
2. Specification of characteristics of each function
3. Determination of required PL (PLr) for each safety function
To: Realization and PL Evaluation

Guard Locking Interlock Safety Function

The safety function is the removal of power from the hazard when the safety system detects that the door has been opened or that the lock has been energized.

Safety Function Requirements

Access to hazardous motion is prevented by using an interlocked guard door with guard locking. Once motor power has been removed, the guard door remains closed and locked for a predetermined amount of time to confirm that the hazardous motion is stopped. When the hazardous motion is stopped, the operator is allowed to unlock the door by applying power to the guard lock. While the door is open, the system is monitored to detect an unexpected start-up. When the door is closed, hazardous motion and power to the motor are not resumed until a secondary action (the Start button is depressed) occurs. Faults at the door interlock switch, wiring terminals, or safety controller are detected before the next safety demand. The stop time of the machine must be established so that the hazardous motion can be stopped before the user reaches the hazard. The safety function in this example is capable of connecting and interrupting power to motors rated up to 9A, 600V AC.

The safety function in this application technique meets or exceeds the requirements for Category 3, Performance Level d (CAT. 3, PLd), per ISO 13849-1 and control reliable operation per ANSI B11.19.

Functional Safety Description

In this example, a request to unlock the door is made by placing a demand on a safety input interlock. The demand on the safety input drops out the redundant contactors, and hazardous motion coasts to a stop. After a five second delay to allow the motion to completely stop, the gate unlocks. The TLS3-GD2 switch is wired to two pairs of safety inputs on a safety input module (SI1). One pair is the lock monitoring contacts and the other is the door monitoring contacts. The safety contactors (K1 and K2) are connected to a pair of safety outputs on a safety output module (SO1). The I/O module is connected via CIP Safety protocol over an EtherNet/IP™ network to the safety controller (SC1). The safety code in SC1 monitors the status of the gate using the pre-certified safety instruction Dual Channel Input Stop with Test and Lock (DCSTL). When all safety input interlocks are satisfied, no faults are detected, and the reset push button is pressed, a second certified function block called Configurable Redundant Output (CROUT) controls and monitors feedback for a redundant pair of 100S-C contactors. In summary, when a demand is placed on a safety interlock, the contactors drop out. Five seconds later, the gate unlocks. When the door is closed and locked, and the reset button is pressed, the contactors are energized.

Bill of Material

This application uses these products.

Cat. No.	Description	Quantity
440G-T27181	TLS3-GD2 power to release safety interlock switch	1
800FM-G611MX10	800F Reset button - metal, guarded, blue, R, metal latch mount, 1 N.O. contact, standard	1
100S-C09ZJ23C	Bulletin 100S-C - safety contactors	2
800FP-MT44PX02	800F non-illuminated mushroom operators, twist to release, 40 mm, round plastic (Type 4/4X/13, IP66), red, 2 N.C. contacts	1
800F-15YE112	800F legend plate, 60 mm round, English: EMERGENCY STOP, yellow with black legend text	1
1768-ENBT	CompactLogix™ EtherNet/IP bridge module	1
1768-L43S	Compact GuardLogix processor, 2.0 MB standard memory, 0.5 MB safety memory	1
1768-PA3	Power supply, 120/240V AC input, 3.5 A @ 24V DC	1
1769-ECR	Right end cap/terminator	1
1734-AENT	24V DC Ethernet adapter	1
1734-TB	Module base with removable IEC screw terminals	4
1734-IB8S	POINT Guard I/O safety input module	1
1734-OB8S	POINT Guard I/O safety output module	1
1783-US05T	Stratix 2000™ unmanaged Ethernet switch	1

Setup and Wiring

For detailed information on installing and wiring, refer to the publications listed in the Additional Resources on the back cover.

System Overview

The 1734-IB8S input module monitors two door channels and two lock channels of the TLS3-GD2 switch.

The 1734-IB8S module can source the 24V DC for all these channels to dynamically test the signal wiring for shorts to 24V DC and channel-to-channel shorts. If a fault occurs, either or both channels are set to 0 (low), and the controller reacts

by dropping out the safety contactors. Only after the fault is cleared and the gate is cycled is the function block reset.

Shorts to 0V DC (and wire off) are seen as an open circuit by the 1734-IB8S input module and the controller reacts by dropping out the safety contactors. If the inputs remain discrepant for longer than the discrepancy time, then the function blocks in the controller safety task declare a fault. Only after the fault is cleared and the gate is cycled is the function block reset.

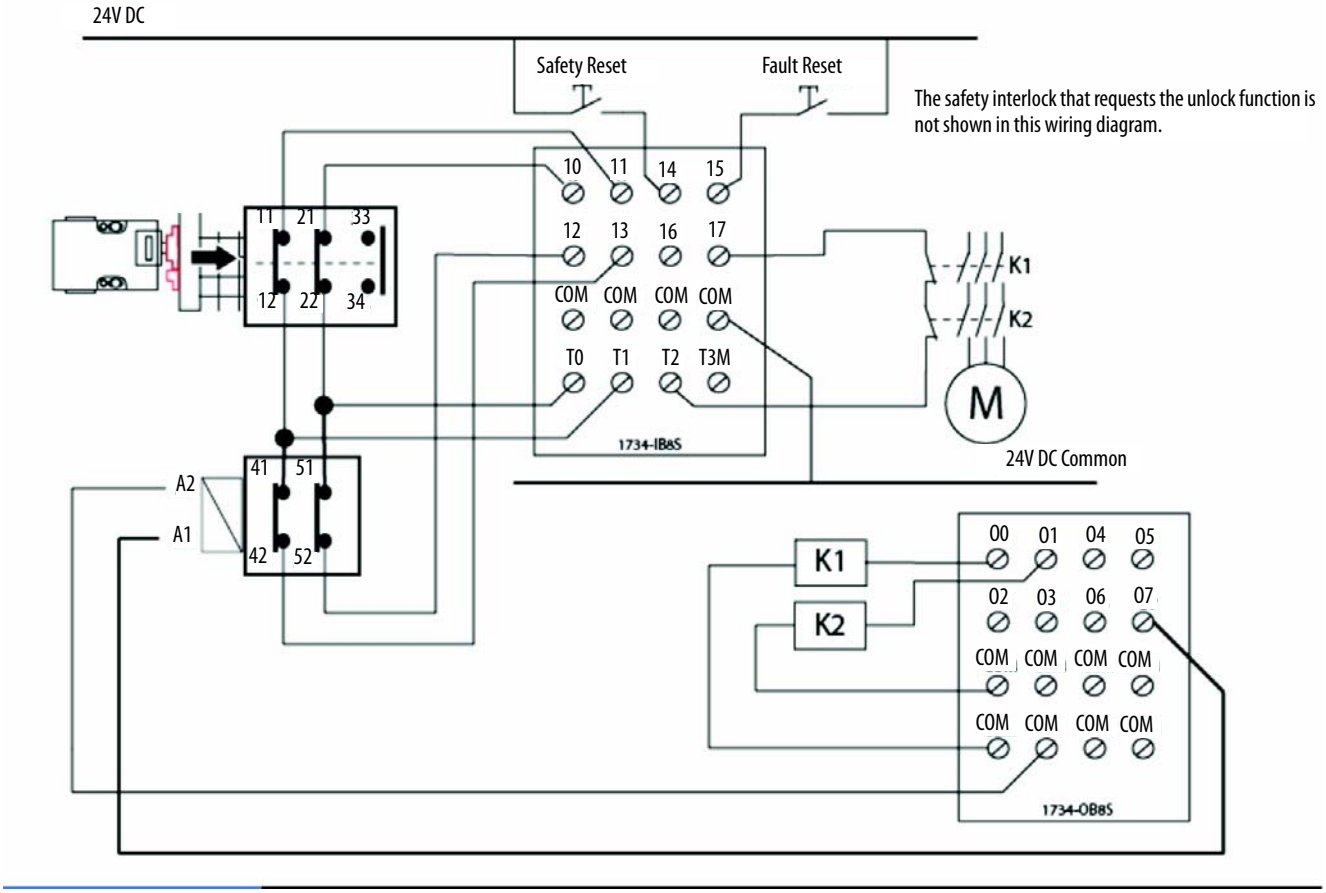
The final control device in this case is a pair of 100S-C safety contactors, K1 and K2. The contactors are controlled by a 1734-OBS safety output module. The contactors are wired in a redundant series configuration. A feedback circuit is wired through the N.C. auxiliary contact and back to an input on the 1734-IB8S module to monitor the contactors for proper operation. The contactors cannot restart if the feedback circuit is not in the correct state.

The system has individual reset buttons for resetting faults and safety outputs.

The reset buttons and the contactor feedback circuit are all wired to the 1734-IB8S module in this example. This is not required for functional safety. These three inputs could be wired to a standard input module.

In this example, the gate solenoid is controlled by a safety output. This is not required for functional safety. The solenoid could be controlled by a standard output. If the solenoid faults to 0 (low), the gate does not unlock. If the solenoid were to fault to 1 (high), the gate unlocks, but unless the Motion Stopped input is 1 (high), the Dual Channel Input Stop with Test and Lock (DCSTL) instruction in the safety task declares a fault and drops out its output. For these reasons, the solenoid is not a part of the safety function.

Electrical Schematic



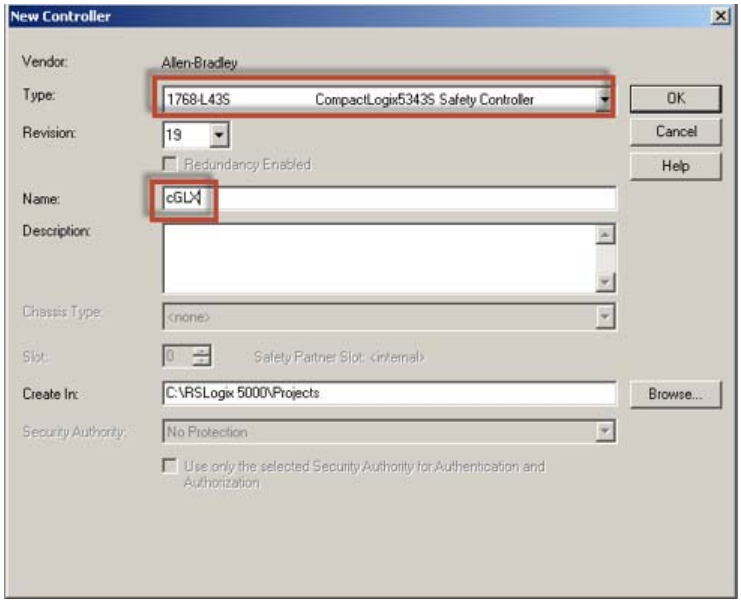
Configuration

The Compact GuardLogix controller is configured by using RSLogix™ 5000 software, version 17 or later. You must create a new project and add the I/O modules. Then, configure the I/O modules for the correct input and output types. A detailed description of each step is beyond the scope of this document. Knowledge of the RSLogix 5000 programming environment is assumed.

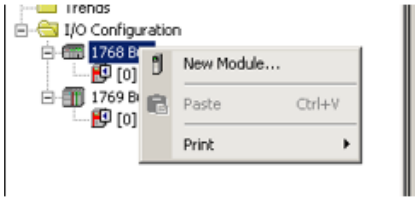
Configure the Controller and Add I/O Modules

Follow these steps to configure the controller and add I/O modules.

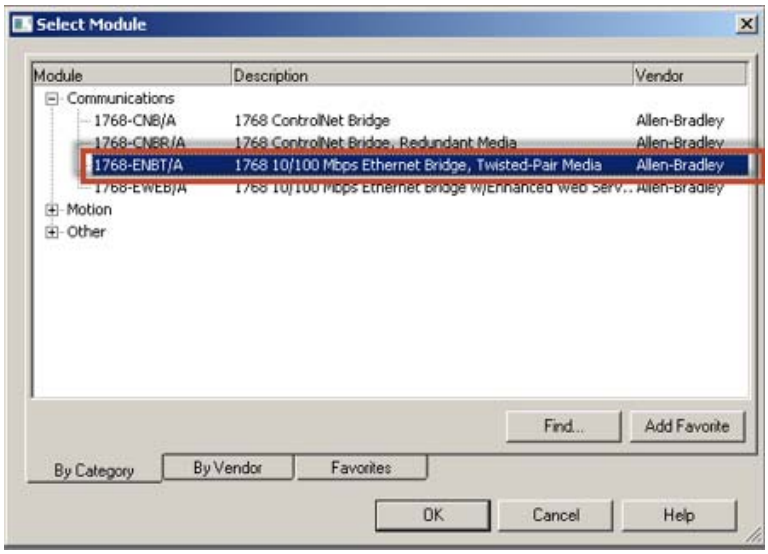
1. In RSLogix 5000 software, create a new project.



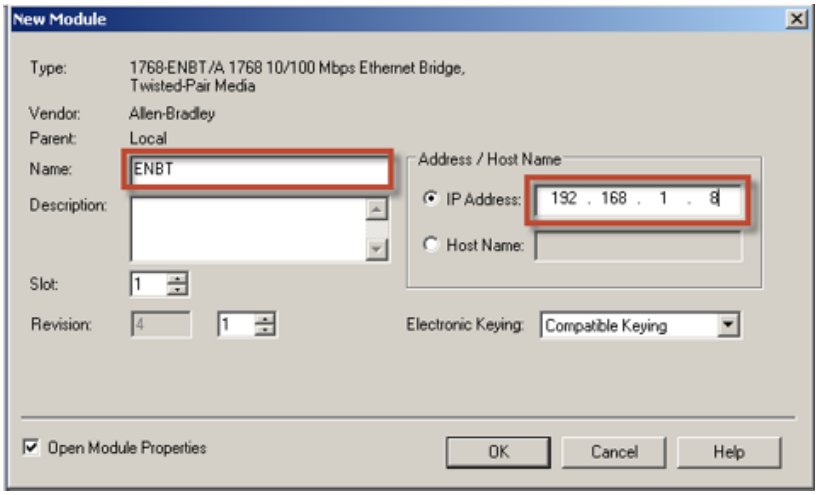
2. In the Controller Organizer, add the 1768-ENBT module to the 1768 Bus.



3. Select the 1768-ENBT module and click OK.

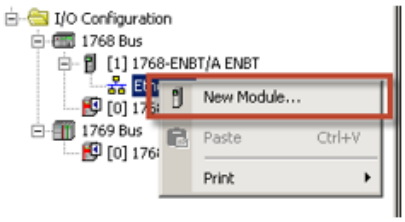


4. In the New Module dialog box, do the following:
   a. Name the module.
   b. Type its IP address.
   c. Click OK.

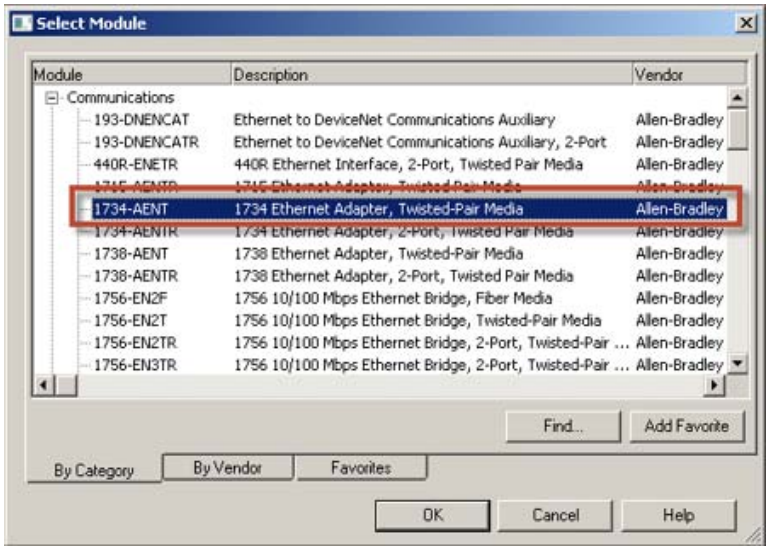


This example uses 192.168.1.8 as the IP address. Yours can be different.

5. To add the 1734-AENT adapter, in the Controller Organizer, right-click the 1768-ENBT module and choose New Module.



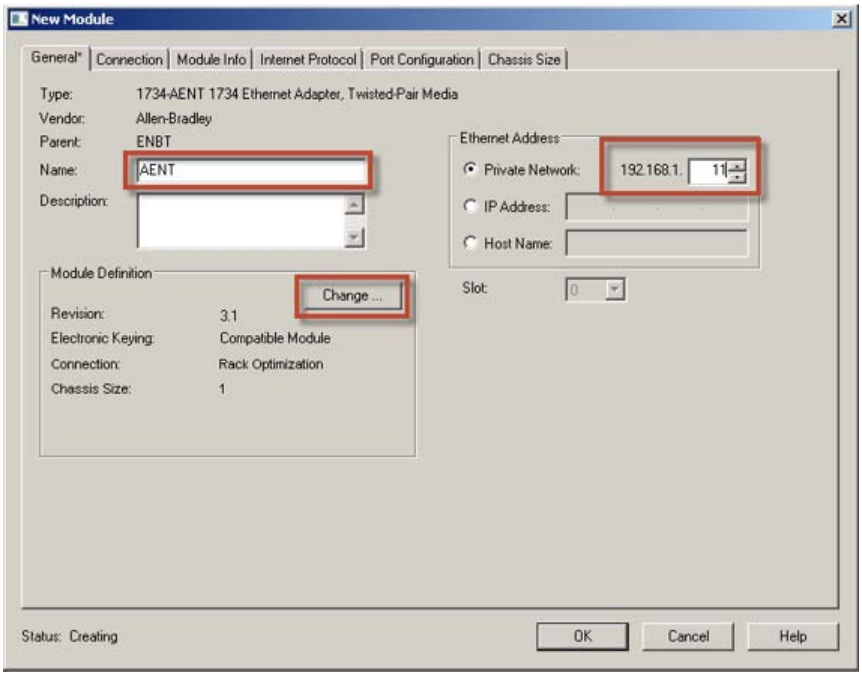
6. Select the 1734-AENT adapter and click OK.



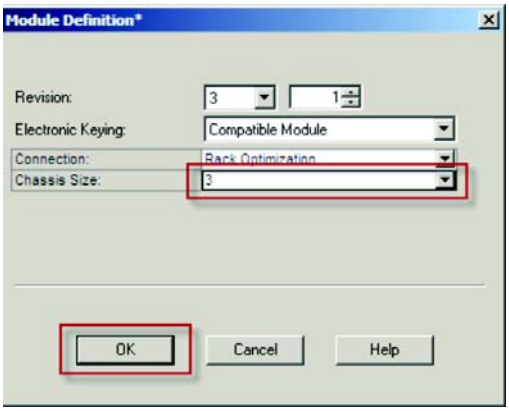
7. In the New Module dialog box, do the following:
   a. Name the module.
   b. Type its IP address.
   c. Click OK.

   This example uses 192.168.1.11 as the IP address. Yours can be different.

8. Click Change.

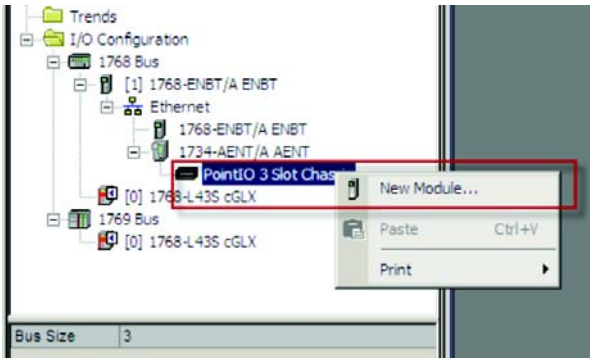


9. Set the Chassis Size as 3 for the 1734-AENT adapter and click OK.

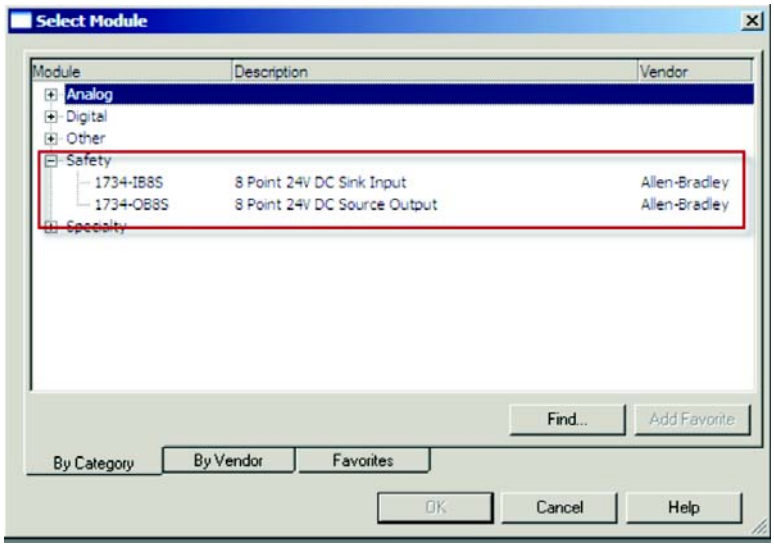


Chassis size is the number of modules that are inserted in the chassis. The 1734-AENT adapter is considered to be in slot 0, so for one input and one output module, the chassis size is 3.

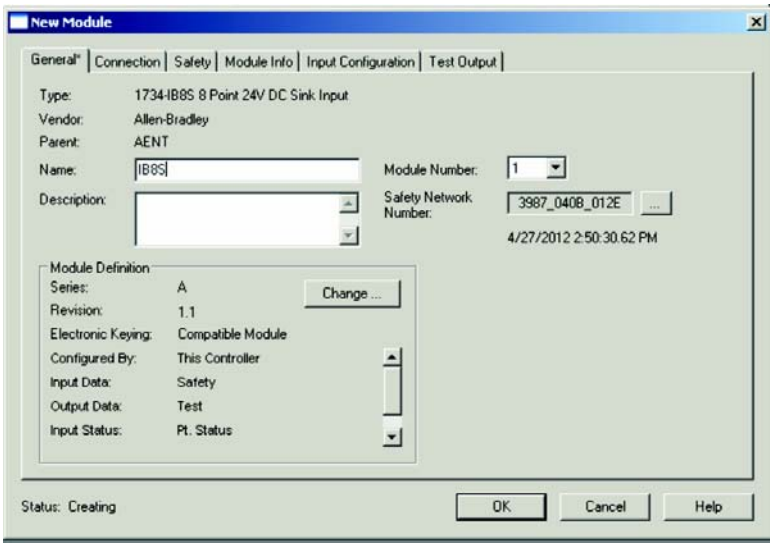
10. In the Controller Organizer, right-click the 1734-AENT adapter and choose New Module.



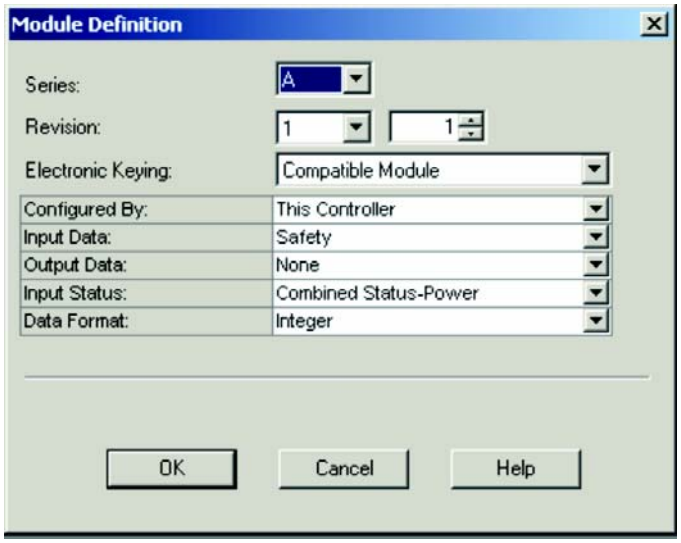
11. Expand Safety, select the 1734-IB8S module, and click OK.



12. In the New Module dialog box, name the device IB8S and click Change.

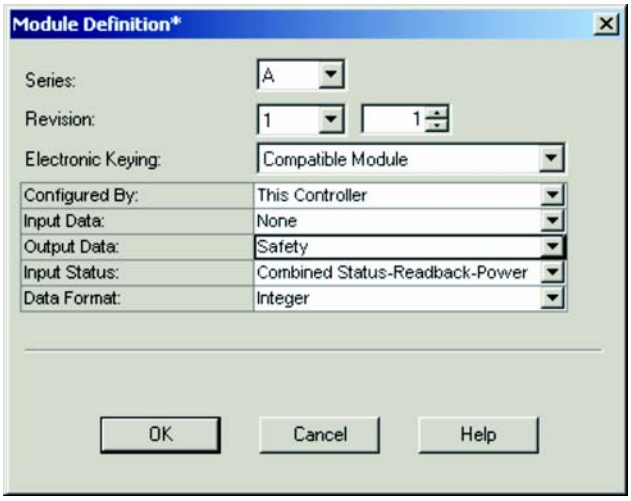


13. When the Module Definition dialog box opens, change the Output Data to None, verify the Input Status is set to Combined Status-Power, and click OK.



IMPORTANT Setting the output data to None means that you cannot use the Test Outputs as standard outputs. This saves one controller connection, because we are only using the input connection.

14. Close the Module Properties dialog box by clicking OK.
15. Repeat steps 10...14 to add the 1734-OB8S safety output module, name the module OB8S, choose slot 2, and choose Combined Status-Readback-Power for Input Status definition.

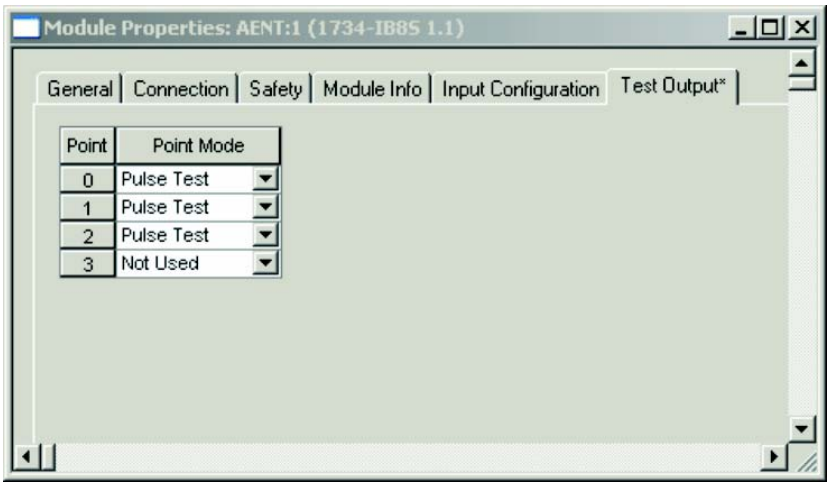


Configure the I/O Modules

Follow these steps to configure the POINT Guard I/O modules.

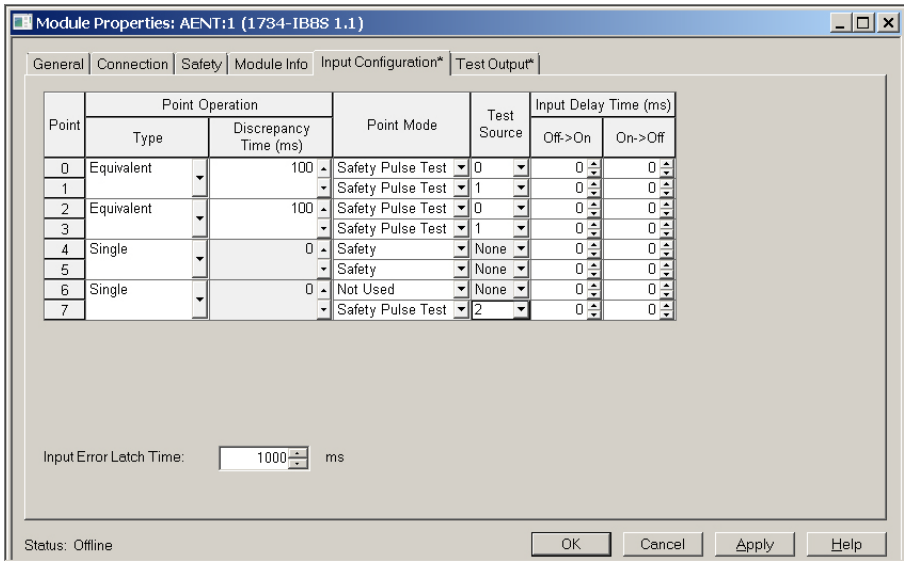
1. In the Controller Organizer, right-click the 1734-IB8S module and choose Properties.

2. Click Test Output and configure the module as shown.



T0 and T1 are being used to pulse test the TLS3-GD2 channels. T2 is being used to pulse test the contactor feedback circuit.

3. Click Input Configuration and configure the module as shown.

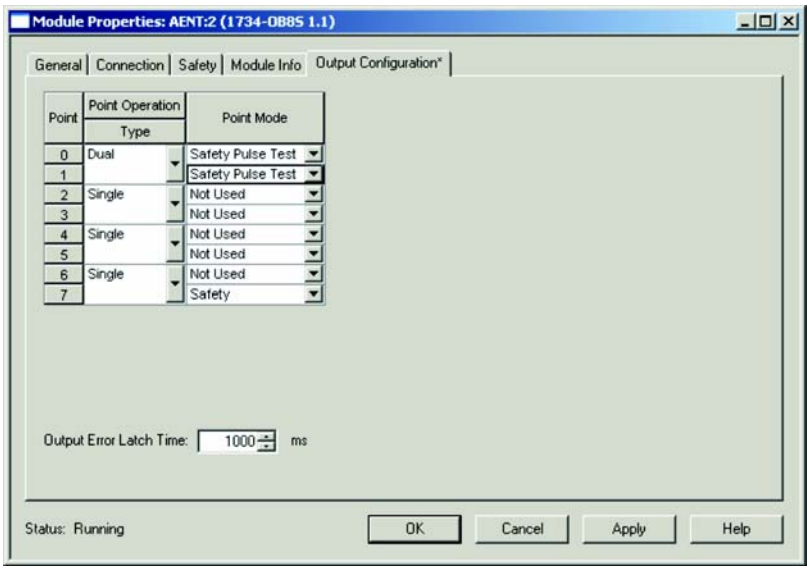


IMPORTANT Inputs 0/1 are the TLS3-GD2 door monitoring contacts. Recall that inputs 0/1 are being sourced from test outputs 0/1. Inputs 2/3 are the lock monitoring contacts. They are also being sourced from test outputs 0/1. Inputs 4/5 are the reset buttons. Input 7 is the contactor monitoring circuit. Recall that input 7 is being sourced from Test Output 2.

4. Click OK.

5. In the Controller Organizer, right-click the 1734-OB8S module and choose Properties.

6. Click Output Configuration and configure the module as shown.



Typically, contactor coils (outputs 0 and 1) do not react to the pulse testing of the output wires. If using a contactor that does react to the pulse test, then disable the pulse testing. This should not affect the overall safety rating if redundancy and monitoring are being used. Output 7 is the TLS3-GD2 locking solenoid.

7. Click OK.

Programming

The Dual Channel Input Stop with Test and Lock (DCSTL) instruction monitors and locks dual channel safety devices whose main function is to stop a machine safely, for example, a safety gate with locking solenoid. When the unlock request goes to 1 (high), the DCSTL instruction waits for the Hazard Stopped input to go to 1 (high), and then turns on the ULC (unlock command) output. At the same time, the output (O1) goes to 0 (low) to indicate that the gate is no longer protecting the hazard. The Lock Feedback should go to 0 (low), indicating the gate is indeed unlocked. The operator can now open the gate. The DCSTL requires that the door monitors (channel A and channel B) cycle at this time or a fault occurs when a restart is attempted. This cycle can be done by opening or closing the gate, or it can be done in software, as shown later in this section.

In this example, the unlock request is generated by placing a demand on the safety interlock being controlled by the Dual Channel Input Stop (DCS) instruction. For this application, all that is required is that the unlock request be set to 0 (low). The demand on the safety interlock drops out the safety contactors, and five seconds later the Hazard Stopped tag is set to 1 (high). This causes the DCSTL instruction to set the ULC output, which energizes output 7 and unlocks the gate.

IMPORTANT The requirements of your application determine the proper way to generate the Hazard Stopped tag.

There are two lock monitoring contacts on the TLS3-GD2 switch, yet there is only one lock feedback tag required for the DCSTL instruction. The Dual Channel Input Monitor (DCM) instruction is used to monitor both lock contacts, and its output is used for the DCSTL Lock Feedback tag.

The DCSTL, DCM, and DCS instructions monitor their respective dual-channel inputs for consistency (Equivalent - Active High) and detect faults when the inconsistency is detected for longer than the configured Discrepancy Time (ms)

The automatic restart type allows the DCSTL and DCS outputs (O1) to reset automatically after a demand. The manual action typically required for safety is provided in rung 6 to reset the safety output enable.

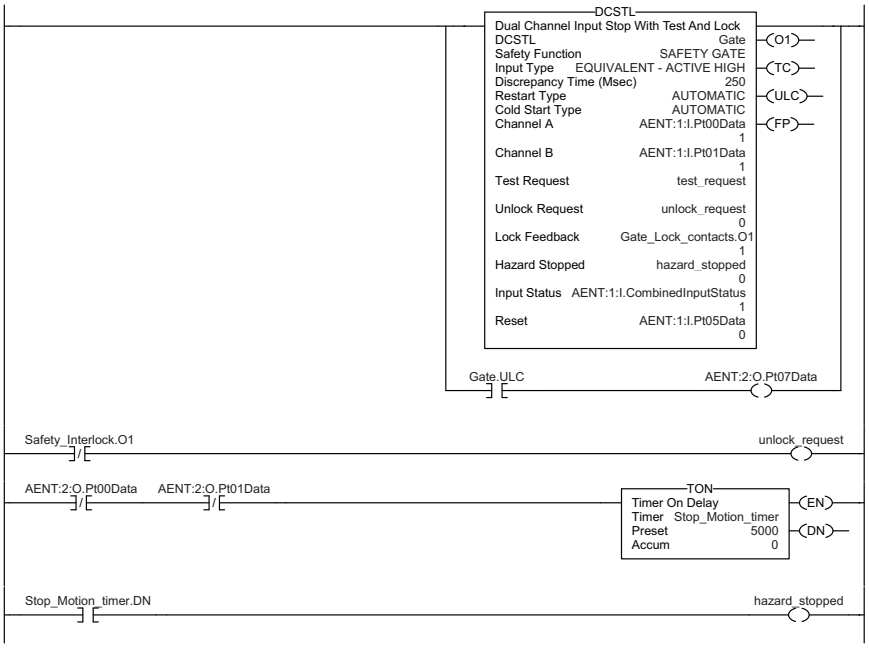
Input Status typically represents the channel status of the two input channels. In this example, the 'Combined Input Status' bit goes to 0 (low) if any of the 8 input channels on the 1734-IB8S module have a fault.

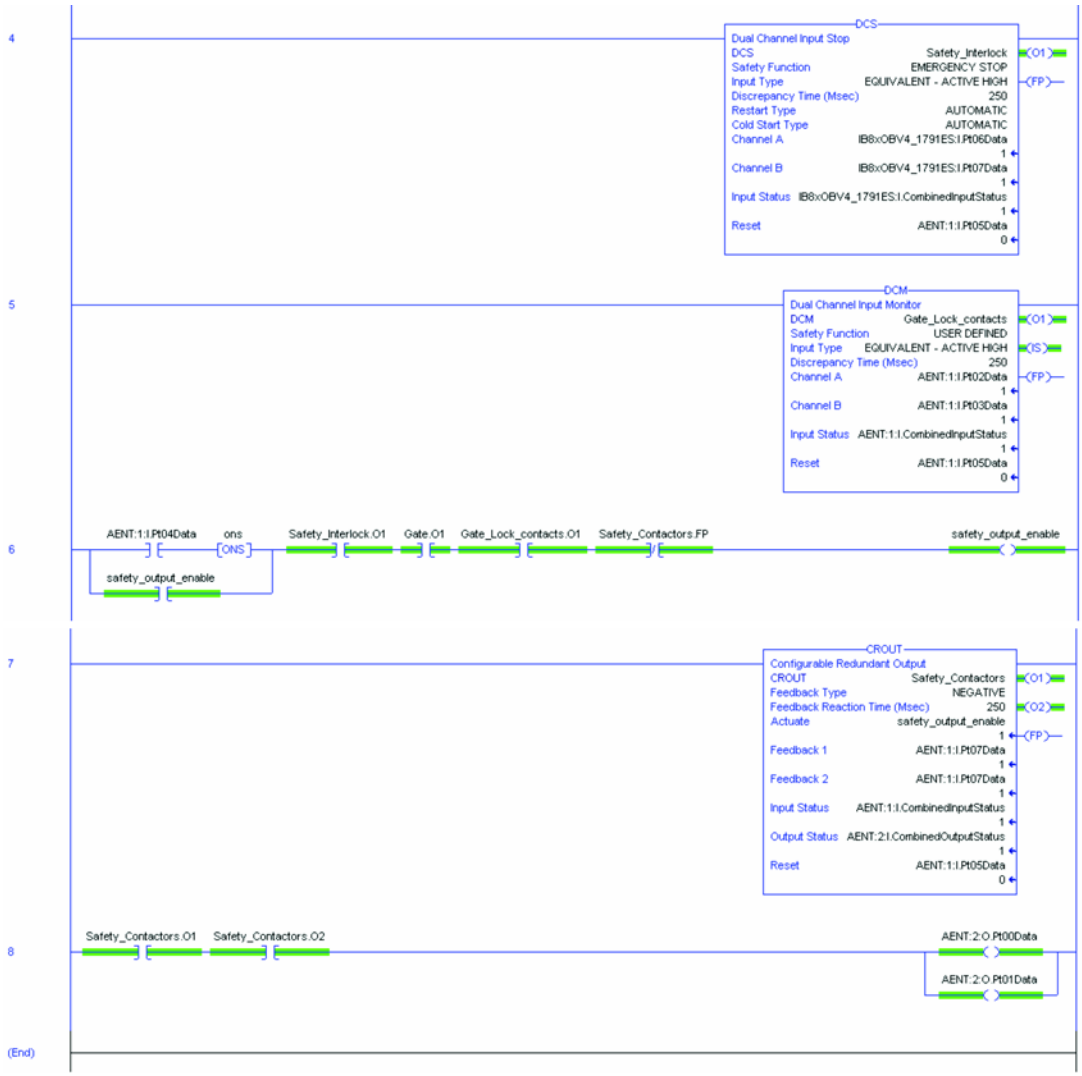
In this example, the DCSTL, DCM, and DCS reset acts as a fault reset. Even when the system is configured for automatic restart, a reset is required to recover from a fault.

The outputs (O1) of the DCSTL, DCM and DCS instructions are used as a safety interlock in the seal-in rung to drive the Output Enable tag. If any of the three outputs drop out, so does the output enable, and it remains OFF until a manual reset action is carried out.

The Configurable Redundant Output (CROUT) instruction controls and monitors redundant outputs. Essentially this instruction verifies that feedback follows the safety outputs appropriately. For the negative feedback used in this example; if the outputs are 1 (high), the feedback should be 0 (low) and vice versa. In this example, the feedback has 500 ms to change to the proper state. Because only a single feedback circuit is being used, the feedback tag is used for both feedback 1 and 2.

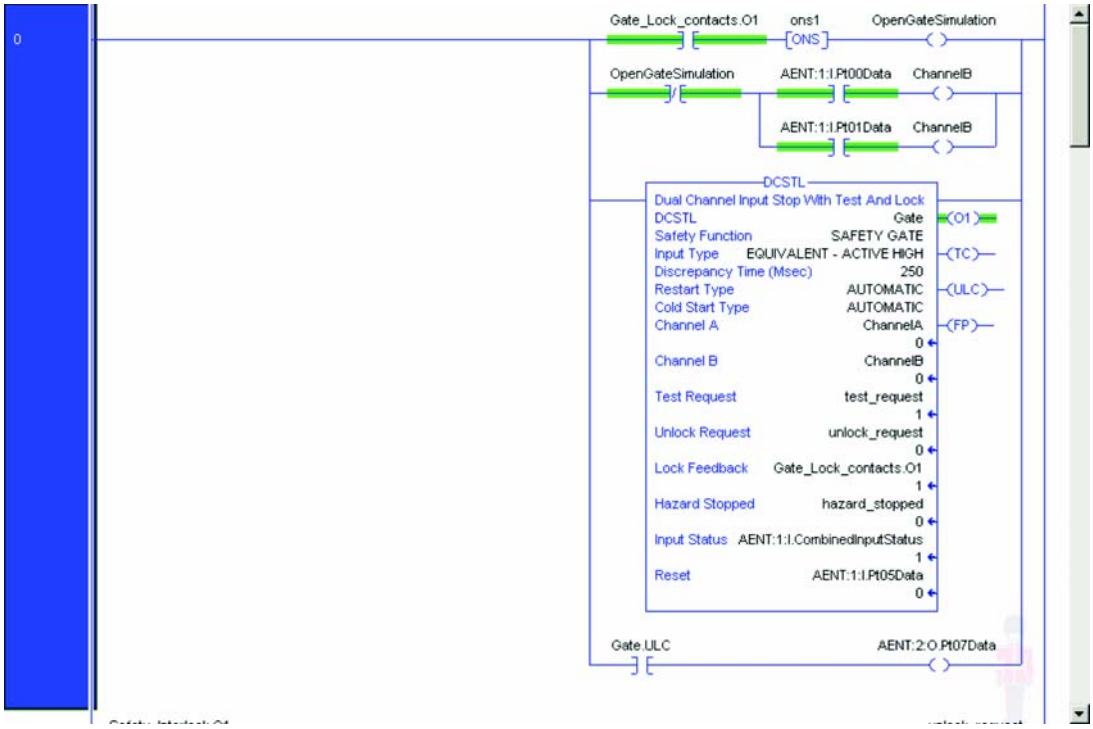
The two output tags from the CROUT instruction are used to drive the contactor outputs on the 1734-OB8S module.





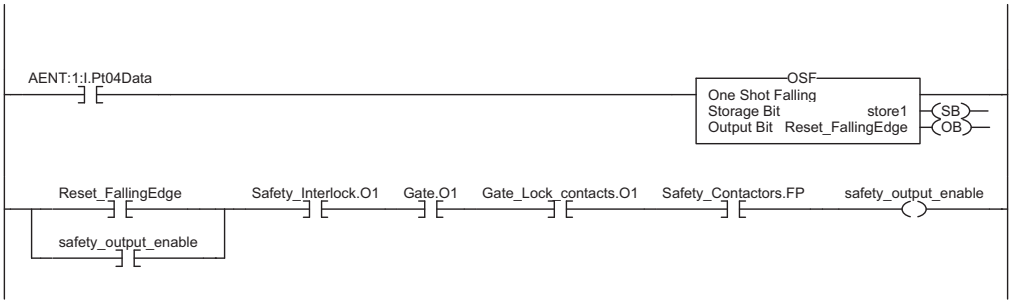
If you wish to use software to programmatically cycle channel A and channel B on the DCSTL instruction, the following code shows one example of how to accomplish this. Whenever the lock feedback goes to 0 (low) for one scan, channel A

and channel B are logically dropped out to satisfy y the DCSTL instruction requirements to cycle the gate. For the rest of the time, the two door monitoring contacts drive the state of channel A and channel B.



Falling Edge Reset

ISO 13849-1 stipulates that instruction reset functions must occur on falling edge signals. To comply with this requirement, a One Shot Falling (OSF) instruction is used on the reset rung. Then, the OSF instruction Output Bit tag is used as the reset bit for the Output Enable rung.

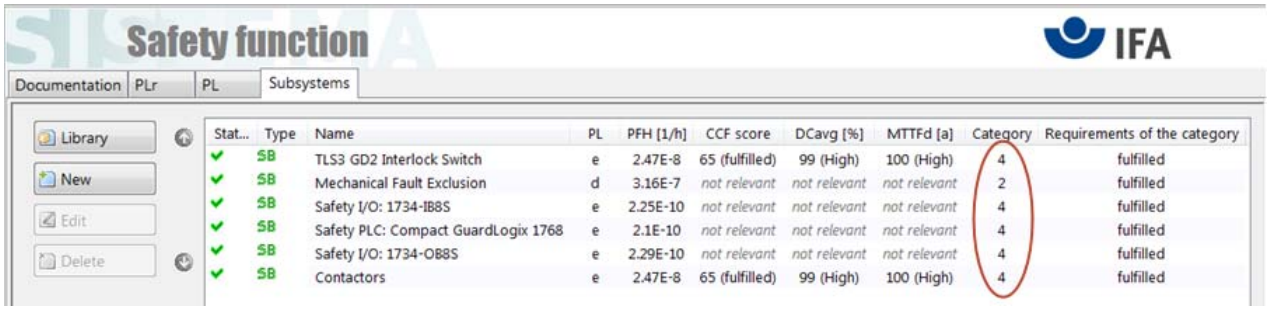


Calculation of the Performance Level

When properly implemented, this Door Monitoring and Locking safety function can achieve a safety rating of Category 3, Performance Level d (CAT. 3, PLd), according to ISO 13849-1: 2008.

The Performance Level required (PLr) from the risk assessment for the safety functions in this application is PLd (minimum) and a structure of Cat. 3 (minimum). A PFHd of less than 1.0E-06 for the overall safety function is required for PLd.

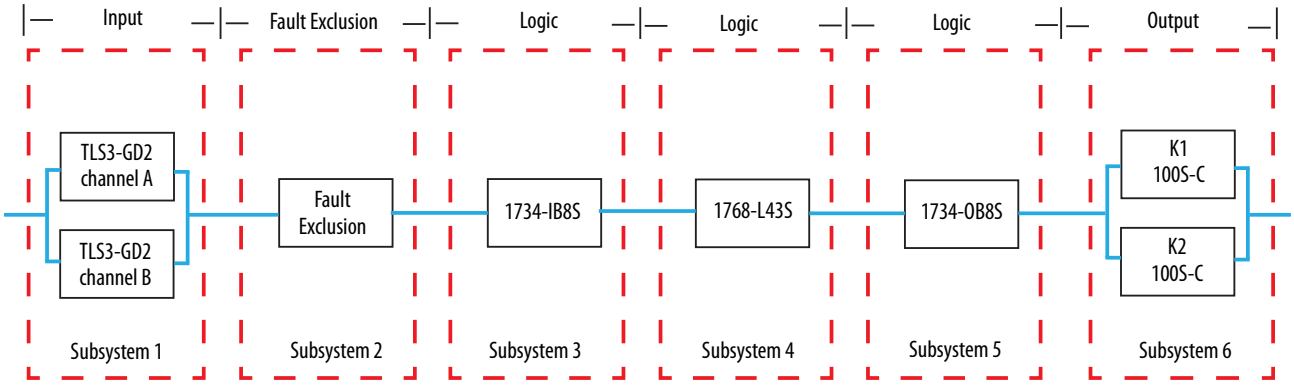
The individual subsystem values are shown below.



Stat...	Type	Name	PL	PFH [1/h]	CCF score	DCavg [%]	MTTFd [a]	Category	Requirements of the category
✔	SB	TLS3 GD2 Interlock Switch	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled
✔	SB	Mechanical Fault Exclusion	d	3.16E-7	*not relevant*	*not relevant*	*not relevant*	2	fulfilled
✔	SB	Safety I/O: 1734-IB8S	e	2.25E-10	*not relevant*	*not relevant*	*not relevant*	4	fulfilled
✔	SB	Safety PLC: Compact GuardLogix 1768	e	2.1E-10	*not relevant*	*not relevant*	*not relevant*	4	fulfilled
✔	SB	Safety I/O: 1734-OB8S	e	2.29E-10	*not relevant*	*not relevant*	*not relevant*	4	fulfilled
✔	SB	Contactors	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled

The overall safety function value is shown below.

The Guard Door Monitoring and Locking safety function can be modeled as shown in the following safety-related block diagram.



Calculations are based on one operation of the safety guard door per hour; therefore 8,760 operations of contactors per year.

The measures against Common Cause Failure (CCF) are quantified using the scoring process outlined in Annex F of ISO 13849-1. For the purposes of the PL calculation, the required score of 65 needed to fulfill the CCF requirement is considered to be met. The complete CCF scoring process must be done when implementing this example.

The TLS3-GD2 switch uses a single-tongue actuator for door monitoring and locking. Due to the inherent strength and simplicity of the actuator design, Fault Exclusion (FE) for this single mechanical actuator is applied in accordance with ISO 13849 Parts 1 and 2.

SB TLS3 GD2 Interlock Switch	
PL	e
PFH [1/h]	2.47E-8
Cat.	4
MTTFd [a]	100 (High)
DCavg [%]	99 (High)
CCF	65 (fulfilled)

SB Mechancial Fault Exclusion	
PL	e
PFH [1/h]	0
Cat.	1
MTTFd [...	FE (High)
DCavg [...	*not relevant*
CCF	*not relevant*

SB POINT Guard I/O: 1734-IB8S	
PL	e
PFH [1/h]	1.34E-10
Cat.	4
MTTFd [a]	*not relevant*
DCavg [%]	*not relevant*
CCF	*not relevant*

SB Safety PLC: Compact GuardLogix 1768	
PL	e
PFH [1/h]	2.1E-10
Cat.	4
MTTFd [a]	*not relevant*
DCavg [%]	*not relevant*
CCF	*not relevant*

SB POINT Guard I/O: 1734-OB8S	
PL	e
PFH [1/h]	1.38E-10
Cat.	4
MTTFd [a]	*not relevant*
DCavg [%]	*not relevant*
CCF	*not relevant*

SB Contactors 100S	
PL	e
PFH [1/h]	2.47E-8
Cat.	4
MTTFd [a]	100 (High)
DCavg [%]	99 (High)
CCF	65 (fulfilled)

Verification and Validation Plan

Verification and Validation play an important role in the avoidance of faults throughout the safety system design and development process. ISO 13849-2 sets the requirements for verification and validation. It calls for a documented plan to confirm all the Safety Functional Requirements have been met.

Verification is an analysis of the resulting safety control system. The Performance Level (PL) of the safety control system is calculated to confirm it meets the Required Performance Level (PLr) specified. The SISTEMA software tool is typically used to perform the calculations and assist with satisfying the requirements of ISO 13849-1.

Validation is a functional test of the safety control system to demonstrate that it meets the specified requirements of the safety function. The safety control system is tested to confirm all of the safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test should include normal operating conditions in addition to potential fault inject of failure modes. A checklist is typically used to document the validation of the safety control system.

Validation of software development is a process in which similar methodologies and techniques that are used in hardware development are deployed. Faults created through poor software development process and procedure are systemic in nature rather than faults associated with hardware which are considered as random.

Prior to validating the GuardLogix Safety System, it is necessary to confirm the safety system and safety application program have been designed in accordance with the GuardLogix System Safety Reference Manual, publication 1756-RM093, and the GuardLogix Application Instruction Safety Reference Manual, publication 1756-RM095.

Verification and Validation Checklist

General Machinery Information		
Machine Name/Model Number		
Machine Serial Number		
Customer Name		
Test Date		
Tester Name(s)		
Schematic Drawing Number		
Controller Name		
Safety Signature ID		
Safety Network Number(s)		
RSLogix 5000 Software Version		
Safety Control System Modules	**GuardLogix Modules**	**Firmware Revision**
GuardLogix Safety Controller	1768-L43S	
CompactLogix Ethernet Bridge	1768-ENBT	
POINT I/O™ Ethernet Adapter	1734-AENT	
POINT Guard I/O Input Modules	1734-IB8S	
POINT Guard I/O Output Modules	1734-OB8S	

GuardLogix Safety System Configuration and Wiring Verification			
Test Step	**Verification**	**Pass/Fail**	**Changes/Modifications**
1	Verify that the safety system is designed in accordance with the GuardLogix System Safety Reference Manual, publication 1756-RM093.		
2	Verify that the safety application program is designed in accordance with the GuardLogix Application Instruction Safety Reference Manual, publication 1756-RM095.		
3	Visually inspect the safety system network and verify that the I/O is wired as documented in the schematics.		
4	Visually inspect the RSLogix 5000 program to verify that the safety system network and I/O module configuration is configured as documented.		
5	Visually inspect the RSLogix 5000 application program to verify suitable safety-certified instructions are used. The logic must be readable, understandable, and testable with the aid of clear comments.		
6	All input devices are qualified by cycling their respective actuators. Monitor the status in the RSLogix 5000 Controller Tags window.		
7	All output devices are qualified by cycling their respective actuators. Monitor the status in the RSLogix 5000 Controller Tags window.		
Normal Operation Verification - The safety relay system properly responds to all normal Start, Stop, E-Stop, Lock, and Reset commands.			
Test Step	**Verification**	**Pass/Fail**	**Changes/Modifications**
1	Initiate a Start command. Both contactors should energize for a normal machine run condition. Verify proper machine status indication and RSLogix 5000 safety application program indication.		
2	Initiate a Stop command. Both contactors should de-energize immediately for a normal machine Stop condition. After the preset time delay, verify that the door unlocks. Verify proper machine status indication and RSLogix 5000 safety application program indication.		
3	While the system is running, attempt to open the guard door. The door should remain closed and locked. Both contactors should remain energized and closed for a normal safe condition. Verify proper machine status indication and RSLogix 5000 safety application program indication. Repeat for all guard doors.		
4	While the system is stopped, attempt to open the guard door. The door should be unlocked and able to be opened. Both contactors should remain de-energized and open for a normal safe condition. Verify proper machine status indication and RSLogix 5000 safety application program indication. Repeat for all guard doors.		
5	While the system is stopped, with the guard door open, initiate a Start command. Both contactors should remain de-energized and open for a normal safe condition. Verify proper machine status indication and RSLogix 5000 safety application program indication. Repeat for all guard doors.		
6	Initiate a Reset command. Both contactors should remain de-energized. Verify proper machine status indication and RSLogix 5000 safety application program indication.		
Abnormal Operation Validation - The GuardLogix safety system properly responds to all foreseeable faults with corresponding diagnostics.			
Door Monitoring and Lock Input Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	While the system is running, remove the door monitor channel 1 wire from the safety I/O. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and repeat for channel 2.		
2	While the system is running, short the door monitor channel 1 of the safety I/O to 24V DC. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and repeat for channel 2.		

3	While the system is running, short the door monitor channel 1 of the safety I/O to 0V DC. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and repeat for channel 2.		
4	While the system is running, short the door monitor channels 1 and 2 of the safety I/O. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and 2 wiring.		
5	While the system is running, short channel 1 to Test Source 1 of the safety I/O. Open the guard door. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and repeat for channel 2.		
6	While the system is running, remove the Lock Monitor channel 1 wire from the safety I/O. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and repeat for channel 2.		
7	While the system is running, short the lock monitor channel 1 of the safety I/O to 24V DC. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and repeat for channel 2.		
8	While the system is running, short the lock monitor channel 1 of the safety I/O to 0V DC. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and repeat for channel 2.		
9	While the system is running, short the lock monitor channel 1 and 2 of the safety I/O. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system cannot be reset and restarted with the fault. Restore channel 1 and 2 wiring.		
GuardLogix Controller and Network Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	While the system is running, remove the Ethernet network connection between the safety I/O and the controller. All contactors should de-energize. Verify proper machine status indication and I/O connection status in the RSLogix 5000 safety application program.		
2	Restore the safety I/O module network connection and allow time to re-establish communication. Verify the Connection Status Bit in the RSLogix 5000 safety application program. Repeat for all safety I/O connections.		
3	While the system is running, switch the controller out of Run mode. All contactors should de-energize. Return the key switch back to Run mode. All contactors should remain de-energized. Verify proper machine status indication and RSLogix 5000 safety application program indication.		
Safety Contactor Output Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	Initiate a Start command. Both contactors should energize for a normal machine run condition. Verify proper machine status indication and RSLogix 5000 safety application program indication.		

2	While the system is running, remove the contactor feedback from the safety I/O. All contactors should remain energized. Initiate a Stop command and attempt a Reset command. The system should not Restart or Reset. Verify proper machine status indication and RSLogix 5000 safety application program indication.		
3	While the system is running, short the contactor feedback to the safety I/O. All contactors should remain energized. Initiate a Stop command and attempt a Reset command. The system should not Restart or Reset. Verify proper machine status indication and RSLogix 5000 safety application program indication.		
4	While the system is stopped, remove the safety output to the door lock. The door should remain locked and all contactors should remain de-energized. Verify proper machine status indication and RSLogix 5000 safety application program indication.		

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Compact GuardLogix Controllers User Manual, publication 1768-UM002	Provides information on how to configure, operate, and maintain Compact GuardLogix controllers.
POINT Guard I/O Safety Modules Installation and User Manual, publication 1734-UM013	Provides information on how to install, configure, and operate POINT Guard I/O modules.
GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093	Contains detailed requirements for how to achieve and maintain safety ratings with the GuardLogix controller system.
GuardLogix Safety Application Instruction Set Reference Manual, publication 1756-RM095	Provides detailed information on the GuardLogix Safety Application Instruction Set.
Safety Accelerator Toolkit for GuardLogix Systems Quick Start Guide, publication IASIMP-QS005	Provides a step-by-step guide on how to use the design, programming, and diagnostic tools in the Safety Accelerator Toolkit.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for how to install a Rockwell Automation® industrial system.
Rockwell Automation Safety Products Catalog, available from the Product Catalogs link at http://www.ab.com	Provides information on safety products available from Rockwell Automation.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.
The SISTEMA Cookbook 4, available at http://www.dguv.de/ifa/Praxishilfen/Software/SISTEMA/SISTEMA-Kochb%C3%BCcher/index-2.jsp	Provides details on how to model safety functions in the SISTEMA tool.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

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For more information on Safety Function Capabilities, visit:

http://marketing.rockwellautomation.com/safety/en/safety_functions

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